DOCUMENT RESUME

ED 479 616 IR 022 220

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TITLE	CoCoFolio: A Web-Based Electronic Portfolio for Enriching Students' Learning by Collaboration.
PUB DATE	2002-10-00
NOTE	7p.; In: E-Learn 2002 World Conference on E-Learning in Corporate, Government, Healthcare, & Higher Education. Proceedings (7th, Montreal, Quebec, Canada, October 15-19, 2002); see IR 022 093. Figure covers text.
AVAILABLE FROM	Association for the Advancement of Computing in Education (AACE), P.O. Box 3728, Norfolk, VA 23514. Tel: 757-623-7588; e-mail: info@aace.org; Web site: http://www.aace.org/DL/.
PUB TYPE	Reports - Descriptive (141) -- Speeches/Meeting Papers (150)
EDRS PRICE	EDRS Price MF01 Plus Postage. PC Not Available from EDRS
DESCRIPTORS	Computer Assisted Instruction; Cooperation; Junior High Schools; Learning Processes; Peer Teaching; *Student Development; *Student Motivation; Universities; *Web Based Instruction

ABSTRACT

A Web-based electronic portfolio, CoCoFolio, was developed for enriching students' learning by collaboration. CoCoFolio consists of two collaboration tools: a multi-layer drawing tool, CoCoBoard, and a small bulletin board, Discussion Board, for each student's submission. These tools support a series of expression activities: expression, sharing, peer review, coaching, and reflection. CoCoFolio was implemented in two applications, in a university and in a junior high school, and it was found to improve students' motivation, increase students' knowledge through peer collaboration, and improve their learning process. (Author)

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CoCoFolio: A Web-based Electronic Portfolio for Enriching Students Learning by Collaboration

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Abstract: *We have developed a web-based electronic portfolio, called CoCoFolio, for enriching students learning by collaboration. It consists of two collaboration tools: a multi-layered drawing tool, called "CoCoBoard", and a small bulletin board, called "Discussion Board", for each student's submission. These tools support a series of expression activities: expression, sharing, peer-review, coaching, and reflection. CoCoFolio was implemented in two applications, in a university and in a junior high school, and it was found to improve students' motivation, increase students' knowledge through peer collaboration, and improve their learning process.*

1. Introduction

A portfolio, which is a collection of student work that represents student's efforts, progress, and achievements, has become popular in K-12 and higher education. It offers many possibilities for learning and assessment. Digitizing portfolios (i.e., electronic portfolios) brings the following benefits: (1) operations such as search, copy, and replace become easy; (2) student-learning processes become open to others; (3) teachers can understand how each student is making progress with their studies and can advise them individually.

There are many electronic portfolio programs available such as HyperStudio [HyperStudio], Florida State's Career Portfolio [FSU Portfolio], Stanford's e-Folio [E-Folio] and ePortfolio consortium [ePortfolio]. The first one is a multimedia authoring tool that enables students at all grade levels to create and enjoy their own experiences in learning. The others are web-based portfolios designed to enable students to portray, and instructors to assess, their learning experience in an integrated, sharable format. They are very effective for archiving and sharing learning experiences of all students in various forms of media; however, they provide few tools for collaboration between students or between students and teachers. Without such collaboration, there is a possibility that students will not reflect sufficiently on their work, and without student reflection, portfolios become a mere collection of student work and much of their learning value is diminished.

In response to these problems, we have developed CoCoFolio, that is, an electronic portfolio for enriching student learning by means of collaboration tools. This paper describes the concept of CoCoFolio and explains the implementation of two pilot applications using it.

2. Concept

To explain the concept behind CoCoFolio, first, expression activities involved in learning are explained in the following. It is very important for students to understand themes deeply and acquire knowledge. In addition, Japanese school education has changed its focus from "passive understanding" to "active understanding".

A series of expression activities represent the relation between one student and others. Basically, to think deeply about a study theme, it is important to put one's thoughts together, then express and reflect on them by oneself. In addition, for students to broaden their knowledge, it is important that they share all learning results with peers and stimulate each other. These expression activities can be divided into the following four stages. By repeating these stages, students can develop certain abilities.

- Expression: A student thinks over a study theme, puts their thoughts together, and presents them.
- Sharing: All students share learning results with peers and get a different perspective on their way of thinking.
- Peer-review and advice: Peers review each other's results and comment on each learning result. Teachers advise all students separately in face-to-face talks.
- Reflection: Each student reads the comments and advice and reflects on their learning results.

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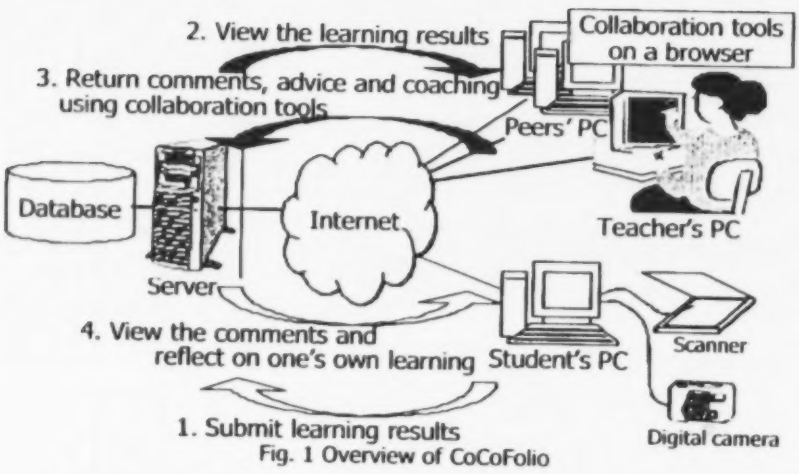


Fig. 1 Overview of CoCoFolio

CoCoFolio supports each stage of the expression activities by using information technologies as follows.

- Expression: It can provide students with a common space on the Internet to share their learning results.
- Share: It can accumulate all learning results in a database and share them with others.
- Peer-review and advice: It can provide peers and teachers with collaboration tools for commenting and giving advice on each student's work.
- Reflection: It enables a student to retrieve their own learning history easily.

Moreover, management tools are very important to enable teachers to make original classes according to their own ideas. For example, learning management can provide teachers who have little database knowledge with a management tool for editing subjects, learning themes, user assignments and so on easily on the Internet.

3. Implementation

3.1 System overview

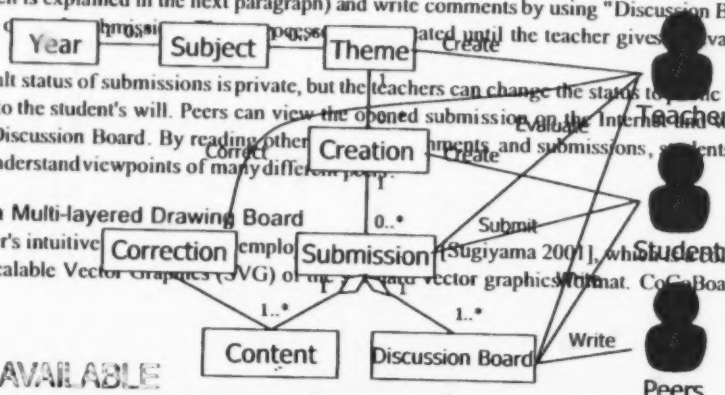
With the above-mentioned concepts in mind, we have developed a student portfolio called CoCoFolio, which consists of the Internet, a web application server, a database, and collaboration tools. Figure 1 shows an overview of CoCoFolio, which utilizes WindowsNT Server 4.0 as the operating system and Oracle as the database. The server software is an extension of our educational software "CyberPedia" [Kakehi 2002]. To use CoCoFolio, a user only needs a web browser like Internet Explorer. Teachers and students can therefore easily access the system from school or even from home.

3.2 Data structure of CoCoFolio

Figure 2 shows the data structure of CoCoFolio. At first, teachers make a learning space by inputting "Year", "Subject", and "Theme", whose relations are similar to directories of a file system. Then, they add some detailed information to the learning theme, such as theme explanation, time limit, and assignment of the students.

The assigned students make their own "Creation" space under "Theme" for submitting their works or creations. "Submission" data is automatically created when the students send their works by a template on a browser. The template allows them to submit a series of "Contents" which consists of a "Media File" like JPEG or MPEG, creator's comments and detailed information about submission. Teachers can make their "Correction" directly to each content by using "CoCoBoard" (which is explained in the next paragraph) and write comments by using "Discussion Board" which is like a mini bulletin board [illegible] until the teacher gives an evaluation in terms of a pass mark.

Basically, the default status of submissions is private, but the teachers can change the status to public and post work on the Internet according to the student's will. Peers can view the opened submission on the Internet and write comments about each other on the Discussion Board. By reading other [illegible] and submissions, students can reflect on their own learning and understand viewpoints of many different people.



3.3 CoCoBoard: a Multi-layered Drawing Board

To support a teacher's intuitive [illegible] employ [illegible] [Sugiyama 2001], which is a collaborative electronic whiteboard using Scalable Vector Graphics (SVG) [illegible] vector graphics format. CoCoBoard has the following

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features.

- Shared whiteboard by means of SVG format: Because of its XML-based format, it is easy to convert or reuse other data and to add metadata to drawing objects. Additionally, the SVG format is less demanding than other raster formats such as JPEG and makes it convenient to communicate using the Internet.
- By means of ActiveX component, CoCoBoard is available on the web and can be used in several applications easily.
- Synchronous or asynchronous communication can be customized according to the collaborative situation on demand.
- Multi-layer canvas architecture provides multiple layers and each layer can be set by teacher, so readable or writable access are available (or both). Even if a student has permission to several access layers, they can view any layer they want by selecting or overlaying them.

By using CoCoBoard, teachers directly overwrite their corrections on a student's work on the Web. It is very convenient for teachers to overwrite directly without running other drawing tools. When the teachers finish overwriting, they upload their corrections via the Internet in asynchronous mode. The CoCoFolio server receives and stores them in a database. Students can view the teacher's corrections by using Adobe SVGViewer and learn something from them. The multi-layer canvas architecture enables teachers to overwrite their corrections on each separated layer. It is therefore possible for students to be coached by several teachers; this is called "team teaching". This function enables teachers and students to learn something from other teachers' coaching.

4. Application examples

To test the performance of CoCoFolio, we asked teachers in Kyoto Seika University (KSU) and Oizumi Junior High School (Oizumi), attached to Tokyo Gakugei University, to use it for supporting their lessons using CoCoFolio. In the KSU experiment, CoCoFolio provided solutions for art and design education, called "Manga University", ("Manga" means cartoon or comic in Japanese.) In the Oizumi experiment, CoCoFolio was applied to "Integrated study" for secondary education.

4.1 Application to art and design education: "MANGA University"

These days, even though there are many web-based education systems, there are few systems for art and design education. This is because it is difficult to aid it by information technology because of its unique features, such as face-to-face coaching and direct coaching through artistic creations. CoCoFolio was applied to solve the trade off between face-to-face coaching and temporal/spatial restrictions.

This experimental project started in May 2001 and involved about 40 students. The workflow of Manga University is as following: (1) The teachers create the themes and assign students. (2) The assigned students submit their scanned creations to the server. (3) The teachers view, modify and comment on each creation by using CoCoBoard. (4) The students view and respond to the teachers' coaching and comments. (5) The students submit new creations.

As shown in Fig. 3, the teacher can directly coach student's creations on the Web. The teacher can coach the students remotely anytime, anywhere, at his convenience. Manga University also allows everyone to easily share the coaching of several teachers. Moreover, it enables students to look back over the past and refer to their history as a personal portfolio.

4.2 Application to various subjects in a junior high school

In Japan, K-12 school education has introduced "Integrated study" styles - similar to the project-based learning in the United States - into the curriculum at the beginning of 2002. It aims to help children develop the capacity and ability to discover problems by themselves and solve them appropriately. The key points of integrated study are that it must be linked with each subject such as mathematics and science and it must guarantee deepness of students understanding by means of expression and reflection.

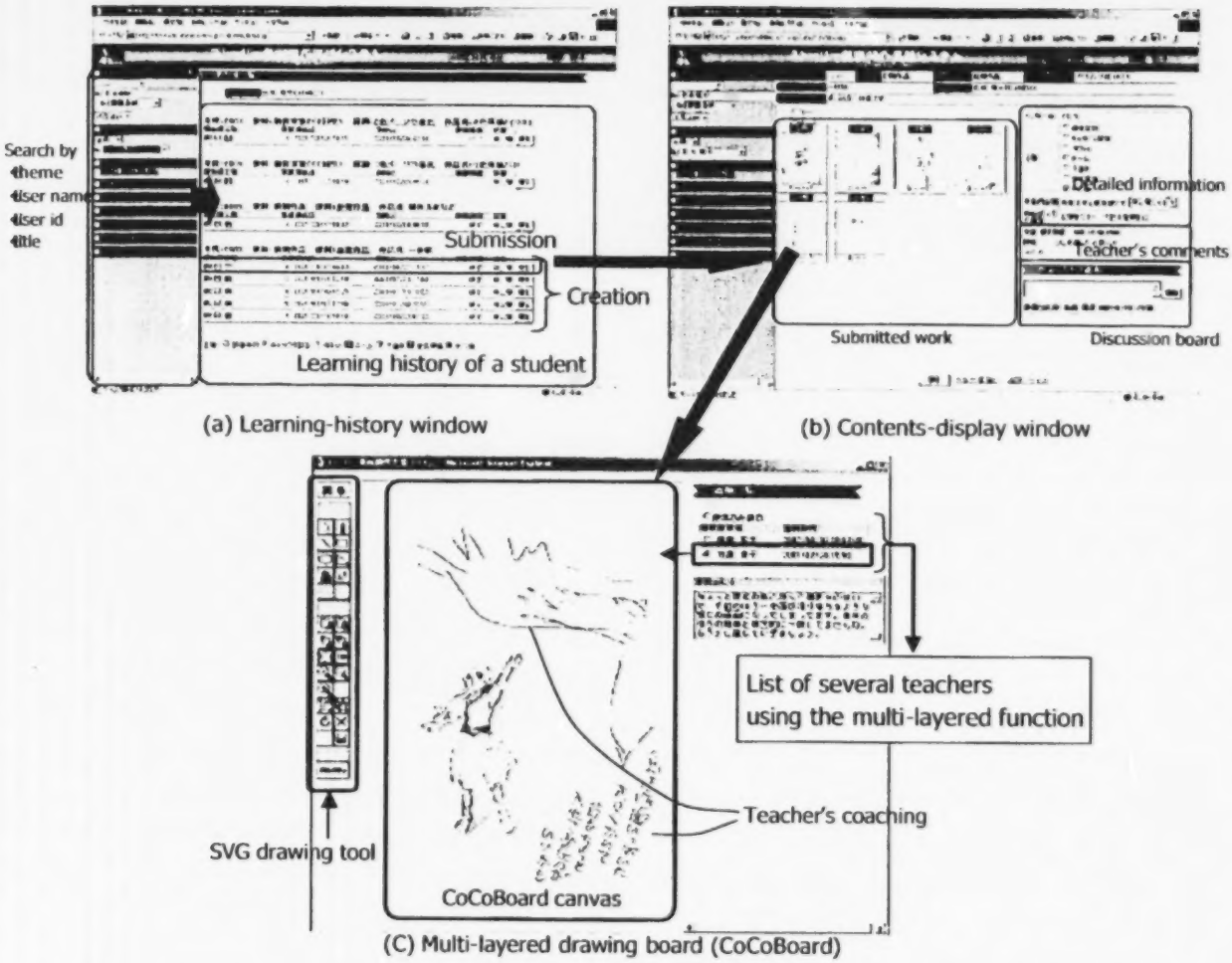

Fig. 3 Screenshots of Manga University

In this application, the Oizumi teachers use CoCoFolio linked with various subjects. This experimental project started in December 2001 and about 130 students are participating in it over a school year. The subjects are science, mathematics, Japanese, and art. Each subject is provided according to the teachers' original ideas. Examples of these classes are given in the following. Note that submitted work from all students (including comments in Discussion Board) becomes the objects of assessment by teachers.

(a) Science class

This 7th-grade learning theme is "plant biology" and involves studying a plant's strategy for existence in winter by observing it regularly. The class flow is as following: (1) Students understand the theme and choose a plant to observe. (2) They observe the plant regularly by using a digital camera and submit articles containing these observations to CoCoFolio. (3) The teacher advises each student on their next activity or on the best way to describe their observations in articles posted on the Discussion Board. The students also give comments and advise on peer's observation articles. (4) They set up a hypothesis concerning the strategy for existence and do an experiment. (5) They make a report and give a short presentation. Figure 4(a) shows the CoCoFolio window containing a student's work. It is clear that the students were thinking deeply by discussing their work on the Discussion Board. Moreover, the teacher's comments were essential to help the student understanding.

(b) Mathematics class

This 8th-grade learning theme is "similarity" and involves making and answering each student's custom questions. The class flow is as following: (1) Students answer original questions from the teacher. (2) They make custom questions by changing part of the original questions and submit them to CoCoFolio. (3) They answer and correct each other's questions. (4) They classify all questions according to the contents. Figure 4(b) shows the CoCoFolio window containing a student's work. The student uploads questions and figures scanned by a scanner. Then, students' and teachers' comments and

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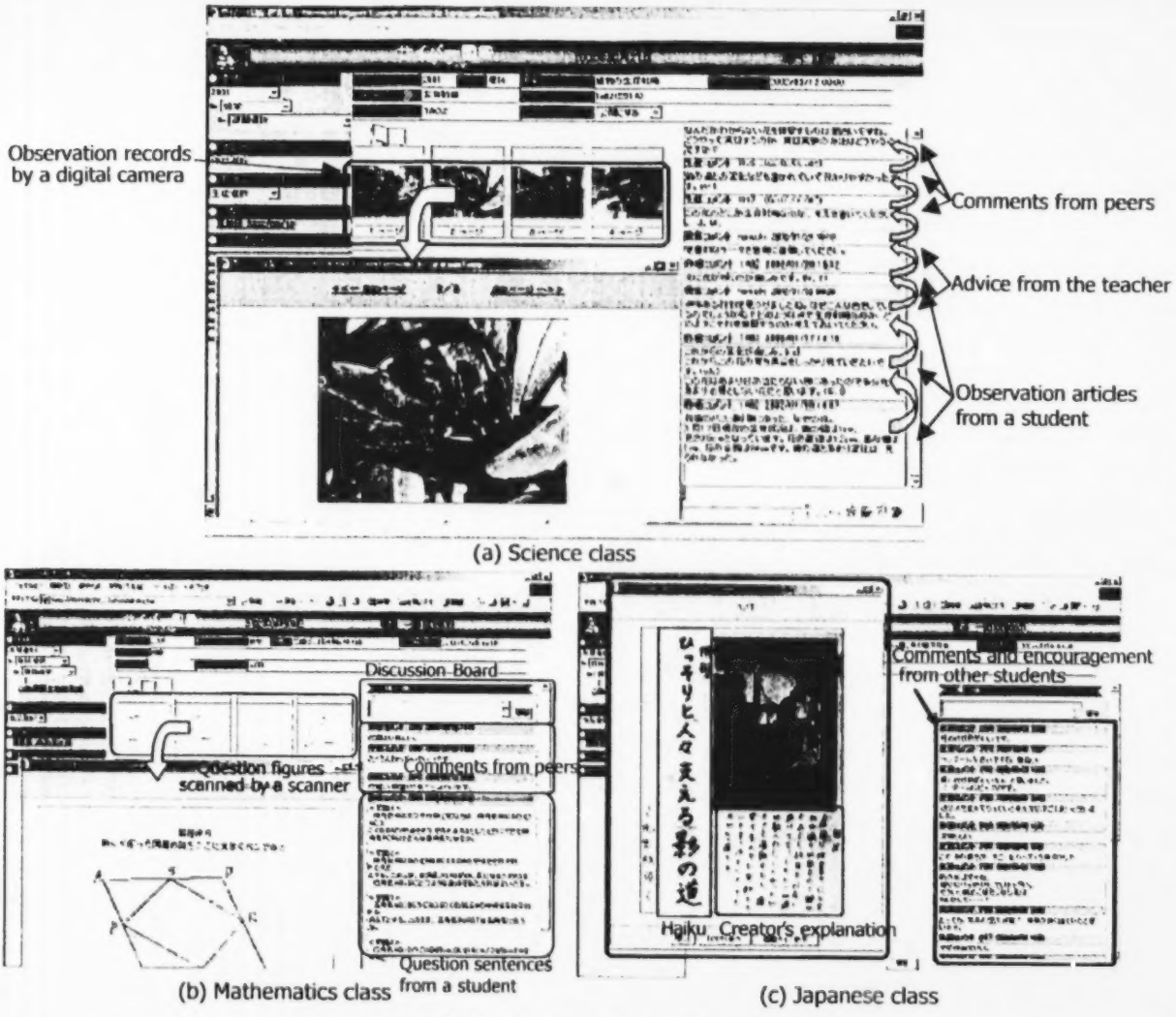

Fig. 4 Screenshots of various subjects in K-12 education

questions are written up on the Discussion Board.

(c) Japanese class

This 7-9th-grade learning theme is "language expression" and involves enriching language expression by making "Haiku" poems with photos in relation to nature or social phenomena. (A "Haiku" is a Japanese poem of seventeen syllables in 5-7-5 form.) Figure 4(c) shows the CoCoFolio window containing a student's work.

5. Discussion

Through observation of some classes, questionnaires from about 90 students, and discussion with the teachers, we came to the following conclusions concerning the use of CoCoFolio.

- Teachers can provide coaching and students can study anytime, anywhere.

Teachers could coach all students separately with CoCoFolio in non-class time. To coach each student separately took much time, but teachers were satisfied with teaching in a "distant face-to-face" style. On the other hand, about two thirds of students accessed the server from their home. Although this is very convenient, it caused a problem due to differences in home-computer environments of different students.

- Teachers can modify and comment on students' creations and works directly by using CoCoBoard.

In particular, in the case of art and design education like MANGA University, teachers need to modify and comment on students' works directly by using CoCoBoard. CoCoFolio is applicable to several other types of art and design education, such as fashion or industrial design as well as storyboard and GUI design for software on the web. Moreover, it can be used for collaborative design work by distant creators.

- Students can reflect on their learning by interacting with peers actively.

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Eighty nine percent of students answered that they could reflect on their learning by viewing their peers' learning histories and by discussing their work on the Discussion Board. Many students wrote that they could try various ways of thinking about the same theme.

- Both students and teachers found CoCoFolio to use very easy.

Ninety seven percent of students answered that they could operate the system easily. Teachers could also use it on a browser, without having any technical knowledge, and make original classes.

- Students' motivation to learn is improved.

The Oizumi students had more fun studying and thinking more deeply than learning all together as a group with textbooks. Students' motivation to learn was improved by sharing learning results and comments from peers.

- CoCoFolio shares coaching comments with other teachers.

Informative comments provide other teachers with useful information; therefore, CoCoFolio also functions as a teaching portfolio.

- Submitted work is accumulated as learning materials for junior students in the school.

Contents in CoCoFolio can be used as learning materials or references for junior students. For example, questions made in the mathematics class make good learning materials for the next year. In addition, teachers can assess learning results by comparing them with those of the previous year.

- Discussion Board helps students to exchange opinions naturally.

Ninety one percent of students answered that they could write their comments interactively. CoCoFolio was really effective for exchanging opinions in their own class and between different classes in school. It will help discussion between different school years, for example, when students teach juniors in the same school.

6. Summary

We have developed and experimentally applied an electronic portfolio tool, called CoCoFolio, for enriching students learning. In two test application examples - at Kyoto Seika University and Oizumi Junior High School - CoCoFolio supports a series of expression activities: expression, sharing, peer-review, coaching, and reflection.

To encourage students to perform these activities, collaboration between students or between students and teachers is essential; therefore, we have developed a multi-layered drawing tool and a Discussion Board. Responding to peers' comments and teachers' coaching, Students can formulate new questions and advance their learning. At the same time, they can understand their peers 'different ways of thinking and improve their learning processes.

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Acknowledgements

We would like to thank Prof. Gunei Sato of Tokyo Gakugei University, Manga artist and Prof. Keiko Takemiya of Kyoto Seika University, and the teachers of Oizumi Junior High School for allowing CoCoFolio to be used in their classes and for giving their helpful comments. We also thank the other project members of NTT for helping and encouraging this project.

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